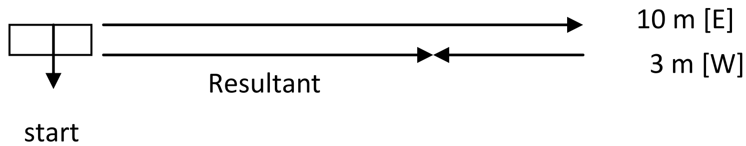
Section 1.2

Vector Quantities :

Displacement - the vector relation to distance, but as measured from a starting reference point.

We will start with some simple one dimensional displacement problems. An object is moved from its starting position a displacement of 10 m [E], then moved back a displacement of 3 m [W]. What is its displacement? (change in position as measured from the reference point)



Displacement is a measure of how far the object ends up from the reference point.

The **Resultant** (net) displacement is 7 m [E]

Mathematically and visually we add the vector values in the order they occur taking into account direction to determine whether the values are added (same direction) or subtracted (opposite direction).

Pick a positive reference direction, and begin your addition. We will choose East as positive for this example.

$\overrightarrow{d_E} = 10 - 3 =$ 7m [E]

What if we had chosen West as are positive direction of reference. Well then ...

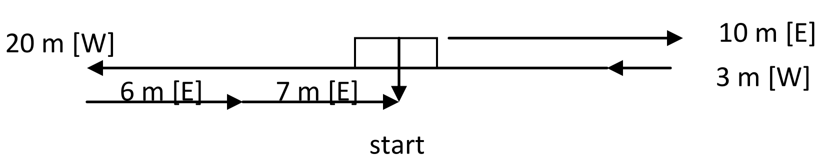
$\overrightarrow{d_W} = -10 + 3 = -$7m [W] recall that with vectors, the negative represents direction not size.

so we can by making life easy for others by switching the direction and the sign at the same time.

- 7 m [W] = + 7 m [E]

Let's take it up a notch in 1D.

An object is moved from its starting position a displacement of 10 m [E], then moved back a displacement of 3 m [W], then moved 20 m [W], then back 6 m [E], 7 m [E]. What is its displacement? (change in position as measured from the reference point)



Displacement is a measure of how far the object ends up from the reference point.

The **Resultant** (net) displacement is 0 m [E]

Mathematically and visually we add the vector values in the order they occur taking into account direction to determine whether the values are added (same direction) or subtracted (opposite direction).

Pick a positive reference direction, and begin your addition. We will choose East as positive for this example.

$\overrightarrow{d_E} = 10 - 3 - 20 + 6 + 7 = 0$ m [E]

** It is possible to run around all day and as long as you end up where you started have a net displacement of zero. **

Velocity - the vector relation to speed, but as measured from a starting reference point.

We have already seen that speed is calculated by taking the distance traveled and dividing it by the time taken. We use a similar approach for velocity except now we need to replace distance by the vector equivalent (displacement).

Ex. 1 A track athlete can run 100 m [N] is 12 s. What is her average velocity?

Sol'n - velocity is the displacement divided by the time taken. $\vec{v} = \frac{\vec{d}}{t}$

<u>givens </u>(need in SI)

$\vec{d}$ = 100 m [N] $\qquad \vec{v} = \frac{100\ m\ [N]}{12\ s}$

t = 12 s $\qquad \vec{v} = 8.33 \frac{m}{s} [N]$

Ex. 2 A track athlete sprints 100 m [N] is 14 s, then turns and sprints back 100 m [S] in 12 s. What is her average velocity?

Sol'n - velocity is the displacement divided by the time taken. $\vec{v} = \frac{\vec{d}}{t}$

<u>givens </u>(need in SI)

$\overrightarrow{d_N}$ = 100 - 100 = 0 m [N] $\qquad \vec{v} = \frac{0\ m\ [N]}{26\ s}$

t = 14 + 12 = 26 s $\qquad \vec{v} = 0 \frac{m}{s} [N]$

** Yes, it is possible to race around a track at a very high speed, yet at a certain point you would have a velocity of zero. **

Question - Is there ever a time when an objects velocity is greater than its calculated speed? Explain.

Assigned questions - page 12, 13 - Practice problems 1 to 4

- page 14 - Practice problems 5 to 9

Plotting Distance and Speed

Recall that distance and speed are scalar quantities and do not depend on the direction of travel.

As a consequence,

a) the distance cannot be less than zero

b) the distance will always be increasing

c) the speed will always be a positive value

Because of these consequences we can use a simple "L" graph to plot the as we did in the Bunny Hop Lab.

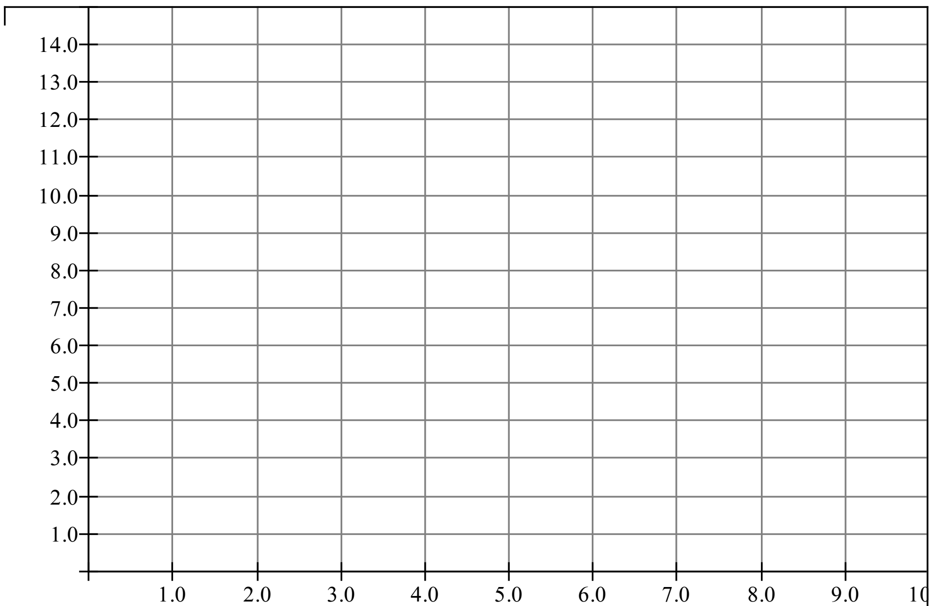
With speed, we can again use the "L" graph to plot the values, but because we will only have a starting time and a finishing time for the distance moved our graph will look a little untraditional. This is due to the need to average the speed over the entire time period.

ex.

Lets say that a dog ran 4 m [N] in 1 s, then 4 m [S] in 2 s, then 3 m [N] in 1 s, and 3 m [S] in 3 s.

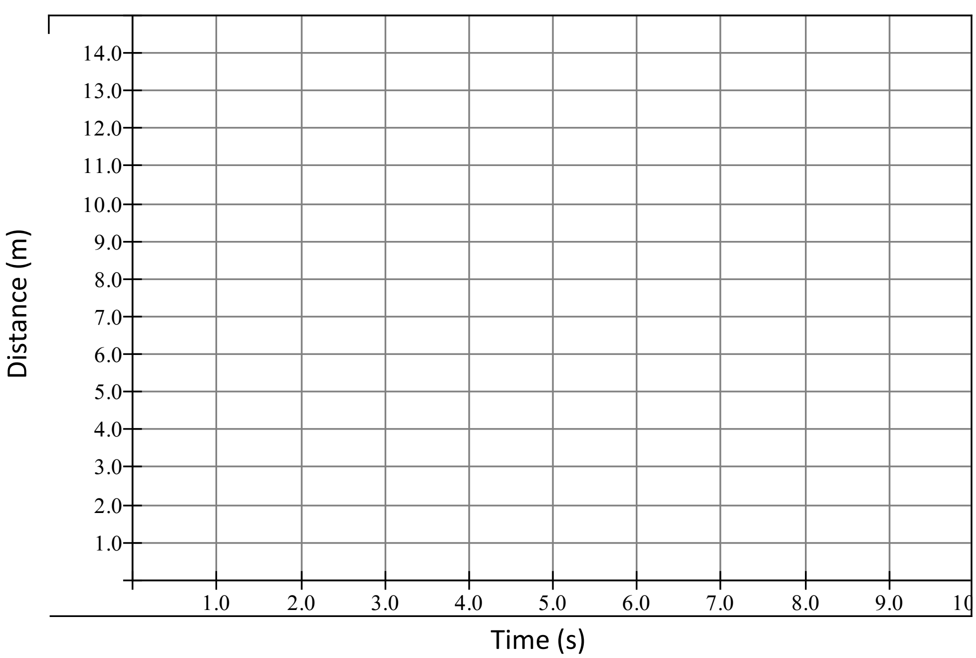
Plot the Distance vs. Time and Speed vs. Time for the described motion.

Start with an "L" graph



1. Add the required axis labels and tiles.

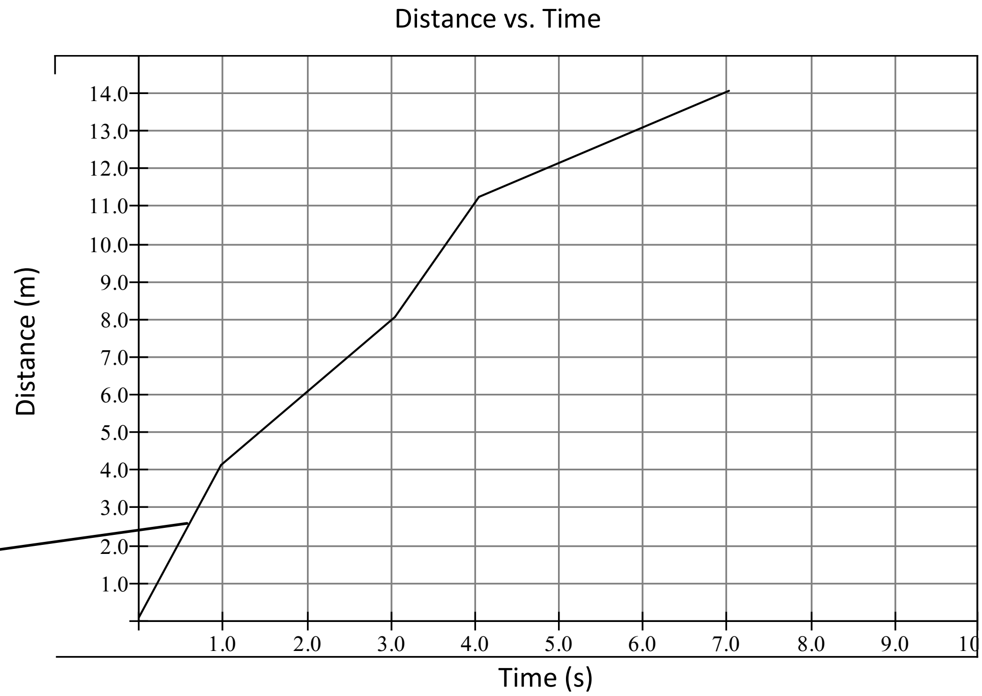
Distance vs. Time



Plot your distance data remembering that each piece of the motion adds to create the total distance traveled (ignore any provided directions).

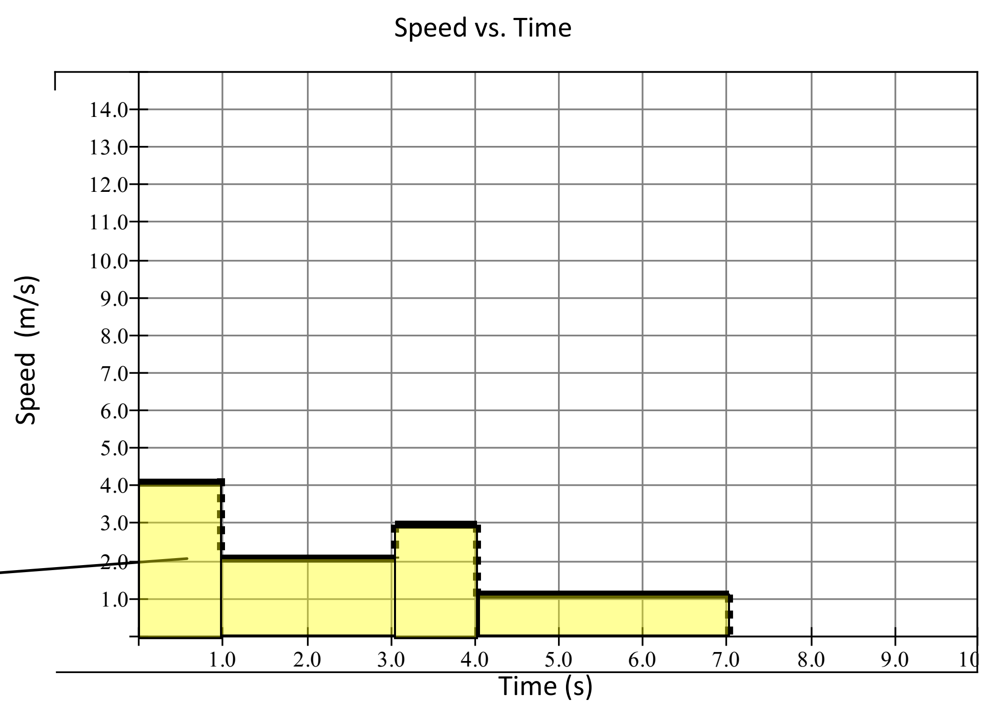
The dog ran 4 m [N] in 1 s, then 4 m [S] in 2 s, then 3 m [N] in 1 s, and 3 m [S] in 3 s.

Time (s)	Distance (m)
0	0
1	4
3	8
4	11
7	14



Slope is used to determine speed

Time (s)	Speed (m/s)
0 - 1	4
1 - 3	2
3 - 4	3
4 - 7	1



Area under the curve determines the distance traveled.

Plotting Displacement and Velocity

Recall that displacement and velocity are vector quantities and do depend on the direction of travel.

As a consequence,

a) the displacement can be less than zero, if the object travels in the "negative direction" relative to the reference point.

b) the slope of a displacement vs. time graph not only indicates speed of the object, but also its direction of travel.

c) due to the direction dependence of velocity, it can also be positive or negative.

Because of these consequences we cannot use a simple "L" graph to plot the as we did in the Bunny Hop Lab, we need to have both positive and negative values so we use a "T" graph.

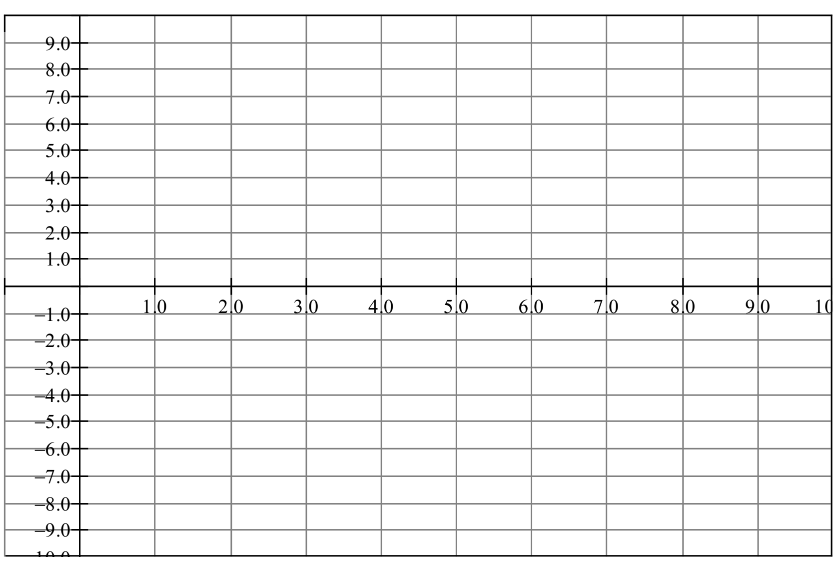
With velocity, we can again use the "T" graph to plot the values, and again because we will only have a starting time and a finishing time for the displacement our graph will look a little untraditional, due to the need to average the velocity over the entire time period.

ex.

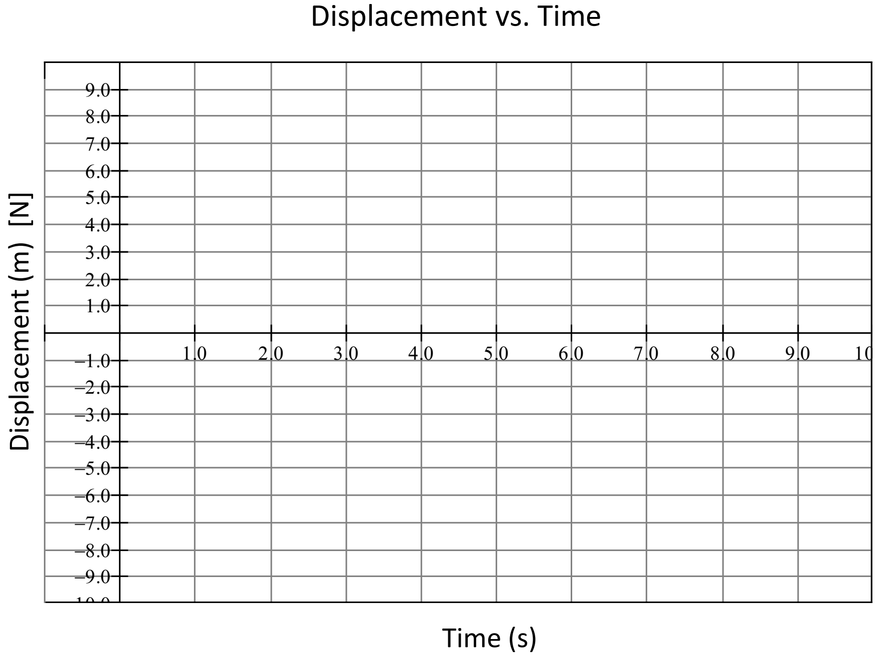
The dog ran 4 m [N] in 1 s, then 4 m [S] in 2 s, then 3 m [N] in 1 s, and 3 m [S] in 3 s.

Plot the Displacement vs. Time and Velocity vs. Time for the described motion.

Start with an "T" graph



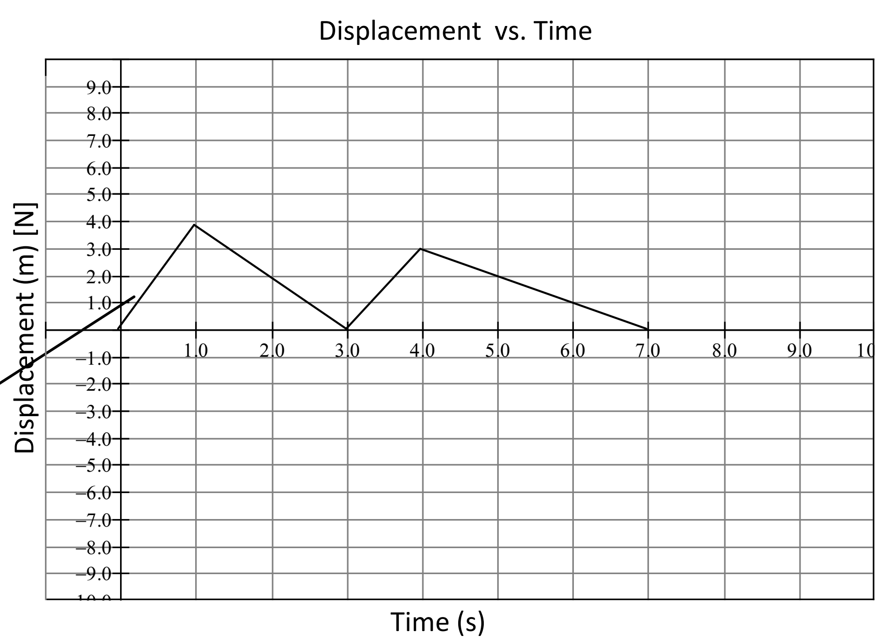
1. Add the required axis labels and tiles.



Plot your displacement data remembering that each piece of the motion adds to create the total displacement traveled (pay special attention to provided directions). For this example I will make North the positive direction.

The dog ran 4 m [N] in 1 s, then 4 m [S] in 2 s, then 3 m [N] in 1 s, and 3 m [S] in 3 s.

Time (s)	Displacement [N] (m)
0	0
1	4
3	0
4	3
7	0



Slope is used to determine elocity

Time (s)	Velocity [N] (m/s)
0 - 1	4
1 - 3	-2
3 - 4	3
4 - 7	-1

Area under the curve determines the displacement traveled. (As measured from line to zero line)